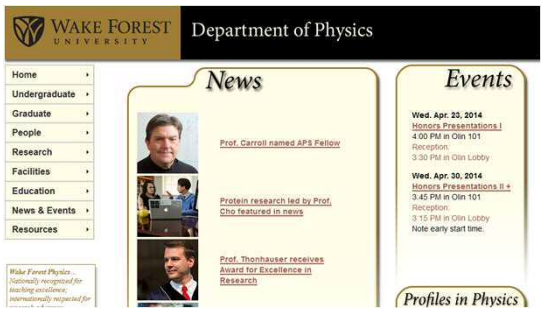
PHY 712 Electrodynamics
10-10:50 AM MWF Olin 107

Plan for Lecture 34:

Special Topics in Electrodynamics:

- ❑ **Review – Scattering and interference phenomena**
- ❑ **Course assessment forms**

	Mon: 03/10/2014	*Spring Break*			
	Wed: 03/12/2014	*Spring Break*			
	Fri: 03/14/2014	*Spring Break*			
19	Mon: 03/17/2014	Chap. 8	Wave guides;Take-home exam due	#18	3/21/2014
20	Wed: 03/19/2014	Chap. 9	Sources of Electromagnetic Waves	#19	3/21/2014
21	Fri: 03/21/2014	Chap. 9	Sources of Electromagnetic Waves	#20	3/28/2014
22	Mon: 03/24/2014	Chap. 11	Special Theory of Relativity	#21	3/28/2014
23	Wed: 03/26/2014	Chap. 11	Special Theory of Relativity	#22	3/28/2014
24	Fri: 03/28/2014	Chap. 11	Special Theory of Relativity	#23	4/04/2014
25	Mon: 03/31/2014	Chap. 14	Radiation from moving charges	#24	4/04/2014
26	Wed: 04/02/2014	Chap. 14	Radiation from moving charges	#25	4/04/2014
27	Fri: 04/04/2014	Chap. 14	Radiation from moving charges	#26	4/11/2014
28	Mon: 04/07/2014	Chap. 14	Radiation from moving charges	#27	4/11/2014
29	Wed: 04/09/2014	Chap. 15	Radiation due to collision processes	#28	4/16/2014
30	Fri: 04/11/2014	Chap. 13	Cherenkov radiation	#29	4/16/2014
31	Mon: 04/14/2014		Special topic -- E&M of superconductivity		
32	Wed: 04/16/2014		Special topic -- E&M of superconductivity		
	Fri: 04/18/2014		Good Friday Holiday -- no class		
33	Mon: 04/21/2014		Special topics and review		
34	Wed: 04/23/2014		Special topics and review		
35	Fri: 04/25/2014		Special topics and review		
	Mon: 04/28/2014		Presentations Part I		
	Wed: 04/30/2014		Presentations Part II		



OREST ITY Department of Physics

WFU Physics Colloquium

TITLE: Physics Honors Theses Presentations I

SPEAKERS: Five Undergraduate Thesis Students

TIME: Wednesday April 23, 2014 at 4:00 PM

PLACE: Room 101 Olin Physical Laboratory

Refreshments will be served at 3:30 PM in the Olin Lounge. All interested persons are cordially invited to attend.

PROGRAM

- James Drewery -- 'Modeling Materials: Comparison of Two PAW Datasets'
- Cameron Kates -- 'Computational Modeling of Surface Energy and Structural Behavior of $Li_4P_2S_6$ Electrolytic Solid Interfacing with Li Anodes'
- Madison Marvel -- 'Platelet Activation in Hemolytic Anemias'
- Margaret Payne -- 'Charge Transfer Complexes of Pyromellitic Dianhydride'
- David Voyles -- 'The Mechanical Properties of Mixed, Electrospun Collagen/Fibrinogen Fibers for Tissue Engineering Purposes'

Jennifer E. Dorand
Ph.D. Defense
Department of Physics,
Wake Forest University

"A SR-90 Irradiation Device for the Study of Cutaneous Radiation Injury from a Radiological Incident"

In the event of a radiological accident or terrorist attack with fissionable materials, Strontium-90, a fission by-product, would likely be released. Due to the low energy and superficial penetration in tissue of β particles from Sr-90 radiation, cutaneous radiation injury (CRI) is a major concern. In the case of a radiation incident, the dose to the skin is unlikely to be known, but can be estimated with a thorough understanding of the

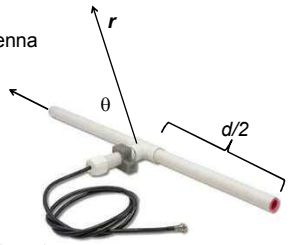
[illegible] rate. Despite great individual source inhomogeneity, a mobile irradiation device was developed that is able to produce a 40 mm diameter area of homogeneous skin dose with a dose rate that is useful for research purposes and clinically relevant for the induction of CRI.

Friday, April 25, 2014 at 9:00 a.m.
Olin Physical Laboratory – Room 107

All interested persons are cordially invited to attend.

Review of radiation from antenna

Linear center-fed antenna



$$\tilde{\mathbf{A}}(\mathbf{r},\omega) \approx \frac{\mu_0}{4\pi}\frac{e^{ikr}}{r}\int d^3r'\, e^{-ik\hat{\mathbf{r}}\cdot\mathbf{r}'}\,\tilde{\mathbf{J}}(\mathbf{r}',\omega)$$

$$\tilde{\mathbf{J}}(\mathbf{r}',\omega) = I_0 \sin\left(\frac{kd}{2} - k\,|\,z\,|\right)\delta(x)\delta(y)\hat{\mathbf{z}}$$

Linear center-fed antenna continued

$$\tilde{\mathbf{A}}(\mathbf{r},\omega) \approx \hat{\mathbf{z}}\frac{\mu_0 I_0}{4\pi}\frac{e^{ikr}}{r}\int_{-d/2}^{d/1} dz'\, e^{-ik\cos(\theta)z'}\, \sin\left(\frac{kd}{2} - k\,|z'|\right)$$

$$= \hat{\mathbf{z}}\frac{\mu_0 I_0}{2\pi}\frac{e^{ikr}}{r}\left(\frac{\cos\left(\frac{kd}{2}\cos\theta\right) - \cos\left(\frac{kd}{2}\right)}{\sin^2\theta}\right)$$

Time averaged power:

$$\frac{dP}{d\Omega} = I_0^{\,2}\sqrt{\frac{\mu_0}{\varepsilon_0}}\frac{1}{8\pi^2}\left|\frac{\cos\left(\frac{kd}{2}\cos\theta\right) - \cos\left(\frac{kd}{2}\right)}{\sin\theta}\right|^2$$

Linear center-fed antenna continued

Time averaged power:

$$\frac{dP}{d\Omega} = I_0^{\,2}\sqrt{\frac{\mu_0}{\varepsilon_0}}\frac{1}{8\pi^2}\left|\frac{\cos\left(\frac{kd}{2}\cos\theta\right) - \cos\left(\frac{kd}{2}\right)}{\sin\theta}\right|^2$$

for $kd = \pi$: $\quad \frac{dP}{d\Omega} = I_0^{\,2}\sqrt{\frac{\mu_0}{\varepsilon_0}}\frac{1}{8\pi^2}\frac{\cos^2\left(\frac{\pi}{2}\cos\theta\right)}{\sin^2\theta}$

for $kd = 2\pi$: $\quad \frac{dP}{d\Omega} = I_0^{\,2}\sqrt{\frac{\mu_0}{\varepsilon_0}}\frac{4}{8\pi^2}\frac{\cos^4\left(\frac{\pi}{2}\cos\theta\right)}{\sin^2\theta}$

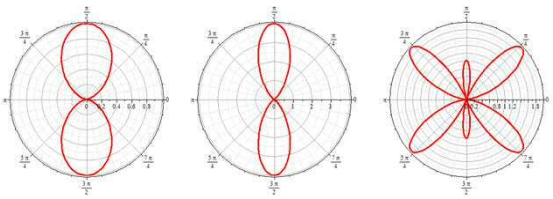
Linear center-fed antenna continued

Time averaged power:

$$\frac{dP}{d\Omega} = I_0^{\,2}\sqrt{\frac{\mu_0}{\varepsilon_0}}\frac{1}{8\pi^2}\left|\frac{\cos\left(\frac{kd}{2}\cos\theta\right) - \cos\left(\frac{kd}{2}\right)}{\sin\theta}\right|^2$$

Radiation patterns $kd = m\pi$:

m=1 *m=2* *m=3*



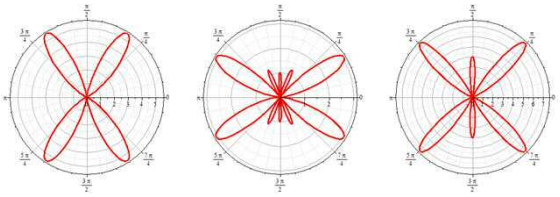
Linear center-fed antenna continued

Time averaged power:

$$\frac{dP}{d\Omega} = I_0^2 \sqrt{\frac{\mu_0}{\varepsilon_0}} \frac{1}{8\pi^2} \left| \frac{\cos\left(\frac{kd}{2}\cos\theta\right) - \cos\left(\frac{kd}{2}\right)}{\sin\theta} \right|^2$$

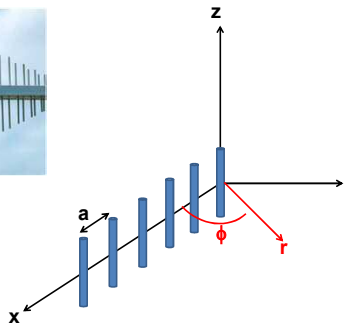
Radiation patterns $kd = m\pi$:

m=4 *m=5* *m=6*

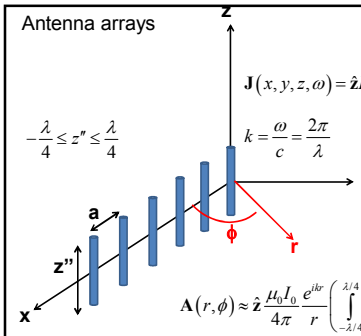


Antenna arrays

http://www.tennadyne.com/company.htm



Antenna arrays



$$\mathbf{J}(x,y,z,\omega) = \hat{\mathbf{z}} I_0 \cos(kz)\delta(y)\sum_{m=0}^{N-1}\delta(x-ma)e^{-i\omega t}$$

$$-\frac{\lambda}{4} \le z'' \le \frac{\lambda}{4} \qquad k = \frac{\omega}{c} = \frac{2\pi}{\lambda} \qquad -\frac{\lambda}{4} \le z \le \frac{\lambda}{4}$$

$$\mathbf{A}(r,\phi) \approx \hat{\mathbf{z}} \frac{\mu_0 I_0}{4\pi} \frac{e^{ikr}}{r} \left(\int_{-\lambda/4}^{\lambda/4} dz \cos(kz) \right) \left(\sum_{m=0}^{N-1} e^{-ikma\cos(\phi)} \right)$$

$$= \hat{\mathbf{z}} \frac{\mu_0 I_0}{2\pi} \frac{e^{ikr}}{kr} e^{-i(N-1)ka\cos(\phi)/2} \frac{\sin(Nka\cos(\phi)/2)}{\sin(ka\cos(\phi)/2)}$$

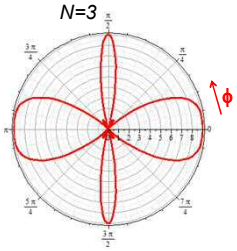
Antenna arrays

$$\mathbf{A}(r,\phi)=\hat{\mathbf{z}}\frac{\mu_0 I_0}{2\pi}\frac{e^{ikr}}{kr}e^{-i(N-1)ka\cos(\phi)/2}\frac{\sin(Nka\cos(\phi)/2)}{\sin(ka\cos(\phi)/2)}$$

Time averaged power in x-y plane:

$$\left\langle\frac{dP}{d\phi}\right\rangle=\frac{\mu_0 c I_0^{\,2}}{8\pi^2}\left(\frac{\sin(Nka\cos(\phi)/2)}{\sin(ka\cos(\phi)/2)}\right)^2$$

N=3



N=12